Air Heater Experience on a Utility Boiler After the Retrofit of SCR Equipment

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SUMMARY

Background

The SCR deNO_X plant on SH Energi's Enstedværket Power Station Unit 3 (EV3) in Denmark is a 'high dust' arrangement with the reactor installed between the economiser exit and the air heater inlet and upstream of the low temperature electrostatic precipitators and FGD plant.

The long-term operating experience with the air heaters at this station is significant in that

- The NO_X reduction targets for the SCR are high (>90% removal)
- The plant operates with a wide range of import coals with sulphur contents up to 2.9%
- The air heaters have been designed to operate at reasonably low gas outlet temperatures

As all of these factors combine to produce an increased risk of air heater fouling, the experience gained is relevant to a wide range of international installations.

The paper reviews the nature of fouling in air heaters after SCR plant and the various counter-measures taken against such fouling. The effectiveness of the measures adopted on EV3 over a 3-year period of operation is described and analysed.

The Effect of NH_3 and SO_3 on Air Heater Fouling

The fouling characteristics of air preheaters after an SCR reactor are related to the ammonia (NH_3) slip through the SCR and the sulphur trioxide (SO_3) content in the inlet flue gas to the air heater. The subsequent formation and condensation of ammonium bisulphate (ABS), together with the condensation of sulphuric acid in the cooling gases through the air heater, can produce significant fouling problems. Moreover, the presence of flyash particles in the gas stream can have a significant effect on the condensation phenomena and the nature and cleanability of the products.

Severe fouling can occur whenever there is sufficient condensation of these species to 'wet' the flyash particles or elements with a sticky layer of either ammonium bisulphate or sulphuric acid.

The paper discusses both the limiting conditions when either species can produce a rising air heater pressure drop and the various counter-measures taken to limit and control this occurrence. As the selection and

arrangement of the heat transfer surfaces can have a significant effect on this fouling, various element selection strategies are compared.

Air Heater Enhancement Data

Howden Power modified the two air heaters on EV3 in the summer of 1996 to make them 'SCR-compatible'. These modifications included an upgrade to the sealing system to reduce the air-to-gas leakage to its lowest possible level. The reduced volume demand on both the FD and ID fans helps compensate for the increased power associated with the SCR pressure loss.

The original three layers of elements were replaced by two layers of elements - with an extended, vitreous enamelled cold end tier to contain both ABS and acid condensation. Each air heater was also fitted with enhanced, twin medium cleaning devices suitable for 'on-line' maintenance and capable of both 'off-load' and 'on-load' water washing.

The paper further presents the typical empirical guideline charts that Howden provide to indicate the minimum average cold end gas and air temperature to avoid cold end fouling and compares the predictions of these guidelines with the operating experience.

Relevant Measured Data

Long Term Ammonia Slip

SH Energi had decided to limit the maximum ammonia in ash content to less than 200mg NH_3/kg of flyash. This was due to environmental concerns with the handling of a product producing a strong smell of ammonia in their open ash disposal system.

The paper describes the long-term upward drift in the ammonia in ash content over the first three years of operation before an additional layer of catalyst was required.

SO_2 to SO_3 Conversion

Before the SCR installation, SH Energi completed a series of measurements of the SO_3 level occurring at the inlet to the air heater over a range of excess air levels and coal sulphur content. After the SCR installation, further SO_3 measurements were made at other points in the system when firing different coals. The paper compares these measurements and draws conclusions about the SO_2 to SO_3 conversion and acid 'knock out' in the air heater, with the amount and nature of the resultant deposition having a significant effect on the air heater fouling.

Relevant Measured Data

Over the first 34 months of operation after the SCR and air heater retrofits, the station operated with a wide range of coals with sulphur contents ranging from 0.6 to 2.9%. In that period, approximately 4.25 million tonnes of coal were burned of which between 450,000 - 550,000 tonnes were medium to high sulphur/low ash coal from the eastern seaboard of the US. This coal was burned intermittently for short periods over the first two years of operation while testing and optimising the FGD system.

The paper describes how the heaters suffered from pressure drop drift after the installation of SCR. It further describes the observations that lead to the conclusion that this drift was caused by acid-enhanced fouling when

firing medium-high sulphur/low ash coal and that such problems were aggravated by unusually high SO_2 to SO_3 conversion in the boiler rather than the SCR plant.

Nevertheless, SH Energi have decided to live with this pressure drop drift in the interests of increased boiler efficiency, making use of the installed combined soot-blowing/high pressure water washing devices to recover the pressure drop with little impact on their generation pattern.

It is further concluded that the retrofitted element and soot-blowing arrangement successfully prevented pressure drop drift due to ABS-enhanced fouling. As this was demonstrated up to the maximum tolerable limit of ammonia in ash content, it is probable that this air heater arrangement can withstand higher levels of ammonia slip with no pressure drop drift.